ExoPlanet News
An Electronic Newsletter

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Contents

1 Editorial

Welcome to the thirty-first edition of ExoPlanet News, an electronic newsletter reporting the latest developments and research outputs in the field of exoplanets.

We are pleased to present a full newsletter this month, containing plenty of exciting new results as well as some interesting announcements and conference notifications. If you'd like to bring your recent papers to the attention of a wider audience, please submit them to the next and future editions – the newsletter now has a circulation of over 1000 readers. Remember that past editions of this newsletter, submission templates and other information can be found at the ExoPlanet News website: http://exoplanet.open.ac.uk.

Please send anything relevant to exoplanet@open.ac.uk, and it will appear in the next edition which we plan to send out at the beginning of September 2010. As for this issue, if you wish to include ONE .eps figure per abstract, please do so.

Best wishes
Andrew Norton & Glenn White
The Open University

2 Abstracts of refereed papers

The $SOPHIE$ search for northern extrasolar planets III. A Jupiter-mass companion around HD 109 246

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Astronomy & Astrophysics, in press (arXiv1006:4984)

We report the detection of a Jupiter-mass planet discovered with the SOPHIE spectrograph mounted on the 1.93-m telescope at the Haute-Provence Observatory. The new planet orbits HD 109 246, a G0V star slightly more metallic than the Sun. HD 109 246b has a minimum mass of 0.77 $M_{\rm Jup}$, an orbital period of 68 days, and an eccentricity of 0.12. It is placed in a sparsely populated region of the period distribution of extrasolar planets. We also present a correction method for the so-called seeing effect that affects the SOPHIE radial velocities. We complement this discovery announcement with a description of some calibrations that are implemented in the SOPHIE automatic reduction pipeline. These calibrations allow the derivation of the photon-noise radial velocity uncertainty and some useful stellar properties ($v \sin i$, [Fe/H], $\log R'_{\rm HK}$) directly from the SOPHIE data.

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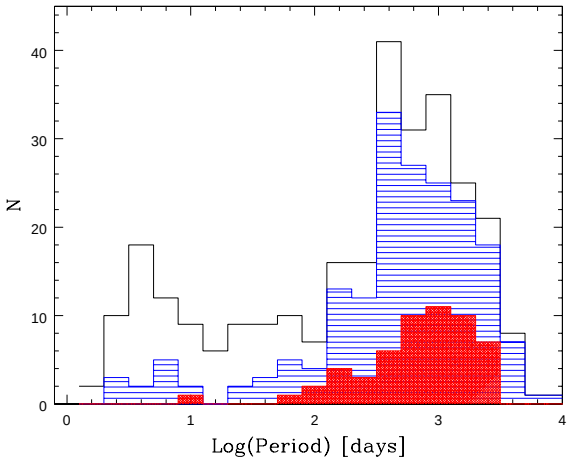

Figure 1: (Boisse et al.) Period distribution of the known extrasolar planet orbiting single dwarf stars discovered via RV surveys. With a period of 68 days, HD 109 246b is in the middle of the "period valley". Horizontal stripped illustrates the distribution for planets more massive than 0.8 M_{Jup} and the shaded one for planets more massive than 4 M_{Jup}.

Characterizing Transiting Extrasolar Planets with Narrow-Band Photometry and GTC/OSIRIS

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Monthly Notices of the Royal Astronomical Society, accepted (arXiv:1006.4599)

We report the first extrasolar planet observations from the 10.4-m Gran Telescopio Canarias (GTC), currently the world's largest, fully steerable, single-aperture optical telescope. We used the OSIRIS tunable filter imager on the GTC to acquire high-precision, narrow-band photometry of the transits of the giant exoplanets, TrES-2b and TrES-3b. We obtained near-simultaneous observations in two near-infrared (NIR) wavebands (790.2 and 794.4±2.0 nm) specifically chosen to avoid water vapor absorption and skyglow so as to minimize the atmospheric effects that often limit the precision of ground-based photometry. Our results demonstrate a very-high photometric precision with minimal atmospheric contamination despite relatively poor atmospheric conditions and some technical problems with the telescope. We find the photometric precision for the TrES-2 observations to be 0.343 and 0.412 mmag for the 790.2 and 794.4 nm light curves, and the precision of the TrES-3 observations was found to be 0.470 and 0.424 mmag for the 790.2 and 794.4 nm light curves. We also discuss how future follow-up observations of transiting planets with this novel technique can contribute to the characterization of Neptune- and super-Earth-size planets to be discovered by space-based missions like *CoRoT* and *Kepler*, as well as measure atmospheric properties of giant planets, such as the strength of atmospheric absorption features.

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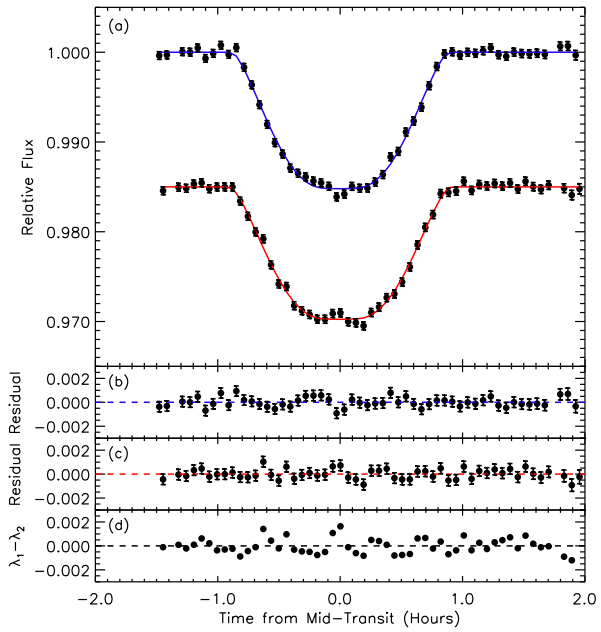

Figure 2: (Colon et al.) Normalized light curves (a), residuals (b,c), and colour (d) for nearly simultaneous observations at 790.2 and 794.4±2.0 nm of TrES-2 as observed on UT 2009 June 25. The filled circles are observations and the lines in panel (a) show the best-fitting models. In panel (a), the 794.4-nm light curve has been arbitrarily offset by 0.015. Panels (b) and (c) show residuals from the fits for the 790.2 and 794.4 nm light curve. The colour of the residuals is shown in panel (d).

An Improved Method for Estimating the Masses of Stars with Transiting Planets.

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Astronomy & Astrophysics, published (2010A&A...516A..33E/1004.1991)

Context. To determine the physical parameters of a transiting planet and its host star from photometric and spectroscopic analysis, it is essential to independently measure the stellar mass. This is often achieved by the use of evolutionary tracks and isochrones, but the mass result is only as reliable as the models used.
Aims: The recent paper by Torres et al. (2010, A&ARv, 18, 67) showed that accurate values for stellar masses and radii could be obtained from a calibration using Teff, log g and [Fe/H]. We investigate whether a similarly good calibration can be obtained by substituting log rho - the fundamental parameter measured for the host star of a transiting planet - for log g, and apply this to star-exoplanet systems.
Methods: We perform a polynomial fit to stellar binary data provided in Torres et al. (2010) to obtain the stellar mass and radius as functions of Teff, log rho and [Fe/H], with uncertainties on the fit produced from a Monte Carlo analysis. We apply the resulting equations to measurements for seventeen SuperWASP host stars, and also demonstrate the application of the calibration in a Markov Chain Monte Carlo analysis to obtain accurate system parameters where spectroscopic estimates of effective stellar temperature and metallicity are available.
Results: We show that the calibration using log rho produces accurate values for the stellar masses and radii; we obtain masses and radii of the SuperWASP stars in good agreement with isochrone analysis results. We ascertain that the mass calibration is robust against uncertainties resulting from poor photometry, although a good estimate of stellar radius requires good-quality transit light curve to determine the duration of ingress and egress.

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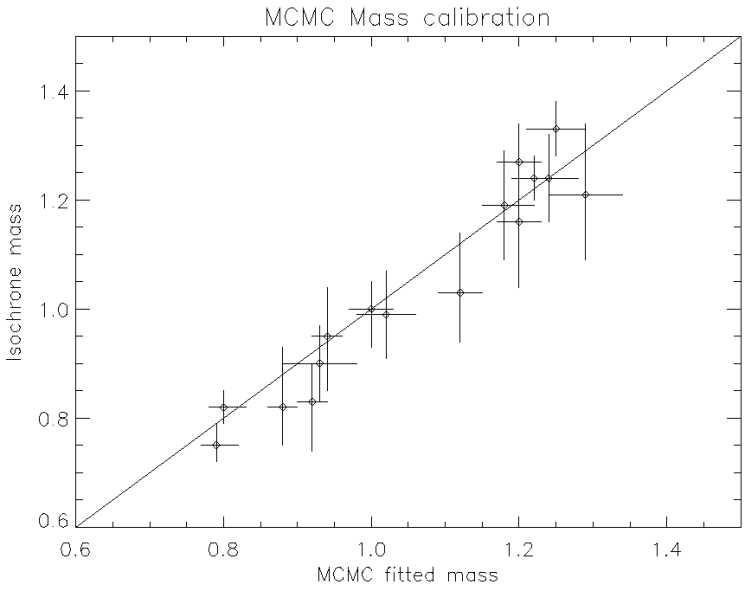

Figure 3: (Enoch et al.) Shows the scatter in isochrone mass values versus values from MCMC analysis for 17 SuperWASP host stars.

Deep infrared imaging of close companions to austral A- and F-type stars

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Astronomy & Astrophysics, accepted (arXiv:1007.0002)

The search for substellar companions around stars with different masses along the main sequence is critical to understand the different processes leading to the formation of low-mass stars, brown dwarfs, and planets. In particular, the existence of a large population of low-mass stars and brown dwarfs physically bound to early-type main-sequence stars could imply that the massive planets recently imaged at wide separations (10–100 AU) around A-type stars are disc-born objects in the low-mass tail of the binary distribution and are thus formed via gravitational instability rather than by core accretion. Our aim is to characterize the environment of early-type main-sequence stars by detecting substellar companions between 10 and 500 AU. The sample stars are also surveyed with radial velocimetry, providing a way to determine the impact of the imaged companions on the presence of planets at $\leq$ 10 AU. High contrast and high angular resolution near-infrared images of a sample of 38 southern A- and F-type stars have been obtained between 2005 and 2009 with the instruments NaCo on the Very Large Telescope and PUEO on the Canada-France-Hawai'i Telescope. Direct and saturated imaging were used in the J to Ks bands to probe the faint circumstellar environments with contrasts of $\sim 5 \times 10^{-2}$ to 10^{-4} at separations of $0.2''$ and $1''$, respectively. Using coronagraphic imaging, we achieved contrasts between 10^{-5} and 10^{-6} at separations $> 5''$. Multi-epoch observations were performed to discriminate comoving companions from background contaminants. This survey is sensitive to companions of A and F stars in the brown dwarf to low-mass star mass regime. About 41 companion candidates were imaged around 23 stars. Follow-up observations for 83% of these stars allowed us to identify a large number of background contaminants. We report the detection of 7 low-mass stars with masses between 0.1 and 0.8 $M_\odot$ in 6 multiple systems: the discovery of a M2 companion around the A5V star HD 14943 and the detection of HD 41742B around the F4V star HD 41742 in a quadruple system; we resolve the known companion of the F6.5V star HD 49095 as a short-period binary system composed by 2 M/L dwarfs. We also resolve the companions to the astrometric binaries ι Crt (F6.5V) and 26 Oph (F3V), and identify a M3/M4 companion to the F4V star o Gru, associated with a X-ray source. The global multiplicity fraction measured in our sample of A and F stars is $\geq 16\%$. This has a probable impact on the radial velocity measurements performed on the sample stars.

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A giant planet imaged in the disk of the young star β Pictoris

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Science, in press (arXiv:1006.3314), published online 10 June 2010; 10.1126/science.1187187

Here we show that the $\sim$ 10 Myr β Pictoris system hosts a massive giant planet, β Pictoris b, located 8 to 15 AU from the star. This result confirms that gas giant planets form rapidly within disks and validates the use of disk structures as fingerprints of embedded planets. Among the few planets already imaged, β Pictoris b is the closest to its parent star. Its short period could allow recording the full orbit within 17 years.

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A Sub-stellar Companion around the F7 V Star HD 8673

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Astrophysical Journal, published (2010ApJ...717..348H)

In order to investigate the dependence of planet formation on stellar mass, we have been monitoring a sample of F-type main-sequence stars with the 2.0-m Alfred-Jensch telescope of the Thüringer Landessternwarte (TLS) Tautenburg. This survey is based on high-precision radial velocity (RV) measurements using the coudé échelle spectrograph and an iodine absorption cell. We present RV measurements of the F7 V star HD 8673 that show a long-term variability of 1634 days with a semi-amplitude $K = 288\ \mathrm{m\,s^{-1}}$ that can be explained most reasonably by an orbiting sub-stellar companion with a minimum mass of 14.2 M_{Jup} in a high-eccentric ($e = 0.723$) Keplerian orbit.

Download/Website: `http://dx.doi.org/10.1088/0004-637X/717/1/348`

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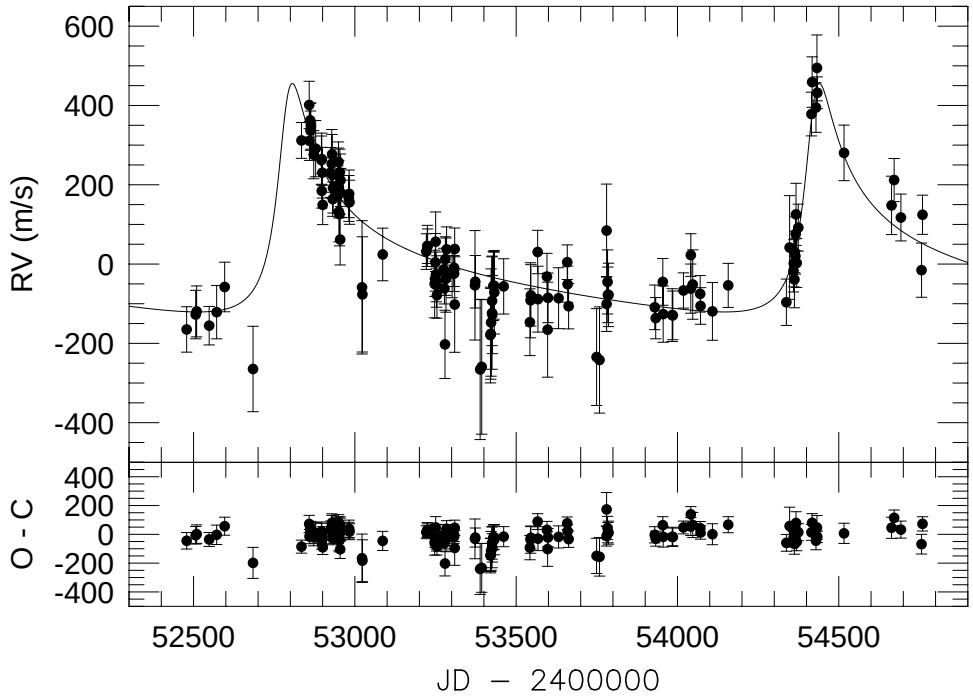

Figure 4: (Hartmann et al.) Radial velocity measurements of HD 8673 and best-fit Keplerian orbital solution (solid line). The RV residuals after subtracting the orbital solution are shown below.

The relevance of prior inclination determination for direct imaging of Earth-like planets

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Monthly Notices of the Royal Astronomical Society, in press (1006.2941)

Direct imaging and characterization of extrasolar Earth-like planets is strongly impacted by the orbital inclination of the planet to be studied, as a combination of pure geometrical effects and the impact of exozodiacal dust. Here, we perform simulations to quantify the impact of a priori knowledge of inclination for the efficiency of a typical coronagraphic or occulter-based mission. The relative impact and complementarity with prior knowledge of exozodiacal brightness down to achievable levels is examined and discussed. It is found that inclination has an even greater impact than the exozodiacal brightness, though the two have excellent complementarity. We also discuss different methods for inclination determination, and their respective applicability to the context of precursor science to an imaging mission. It is found that if technologically achievable, a combined effort to determine inclinations and exozodiacal brightnesses with ground-based facilities would substantially increase the efficiency of a space-based dedicated mission to image and characterize Earth-like planets.

Download/Website: `http://arxiv.org/abs/1006.2941`

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The Directly Imaged Planet around the Young Solar Analog 1RXS J160929.1-210524: Confirmation of Common Proper Motion, Temperature and Mass

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Astrophysical Journal, in press (arXiv:1006.3070)

Giant planets are usually thought to form within a few tens of AU of their host stars, and hence it came as a surprise when we found what appeared to be a planetary mass ($\sim 0.008\,M_\odot$) companion around the 5 Myr-old solar mass star 1RXS J160929.1-210524 in the Upper Scorpius association. At the time, we took the object's membership in Upper Scorpius —established from near-infrared, H- and K-band spectroscopy— and its proximity (2.2″, or 330 AU) to the primary as strong evidence for companionship, but could not verify their common proper motion. Here, we present follow-up astrometric measurements that confirm that the companion is indeed co-moving with the primary star, which we interpret as evidence that it is a truly bound planetary mass companion. We also present new J-band spectroscopy and 3.0-3.8 μm photometry of the companion. Based on a comparison with model spectra, these new measurements are consistent with the previous estimate of the companion effective temperature of 1800 ± 200 K. We present a new estimate of the companion mass based on evolution models and the calculated bolometric luminosity of the companion; we obtain a value of $0.008^{+0.003}_{-0.002}\ M_\odot$, again consistent with our previous result. Finally, we present angular differential imaging observations of the system allowing us to rule out additional planets in the system more massive than 1 $M_{\rm Jup}$, 2 $M_{\rm Jup}$ and 8 $M_{\rm Jup}$ at projected separations larger than 3″ ($\sim$440 AU), 0.7″ ($\sim$100 AU) and 0.35″ ($\sim$50 AU), respectively. This companion is the least massive known to date at such a large orbital distance; it shows that objects in the planetary mass range exist at orbital separations of several hundred AU, posing a serious challenge for current formation models.

Download/Website: `http://arxiv.org/abs/1006.3070`

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Transit timing variation in exoplanet WASP-3b

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Monthly Notices of the Royal Astronomical Society, in press (arXiv:1006.1348)

Photometric follow-ups of transiting exoplanets may lead to discoveries of additional, less massive bodies in extrasolar systems. This is possible by detecting and then analysing variations in transit timing of transiting exoplanets. We present photometric observations gathered in 2009 and 2010 for exoplanet WASP-3b during the dedicated transit-timing-variation campaign. The observed transit timing cannot be explained by a constant period but by a periodic variation in the observations minus calculations diagram. Simplified models assuming the existence of a perturbing planet in the system and reproducing the observed variations of timing residuals were identified by three-body simulations. We found that the configuration with the hypothetical second planet of the mass of $\sim$15 Earth masses, located close to the outer 2:1 mean motion resonance is the most likely scenario reproducing observed transit timing. We emphasize, however, that more observations are required to constrain better the parameters of the hypothetical second planet in WASP-3 system. For final interpretation not only transit timing but also photometric observations of the transit of the predicted second planet and the high precision radial-velocity data are needed.

Download/Website: `http://arxiv.org/abs/1006.1348`

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The Lick-Carnegie Exoplanet Survey: A Uranus-mass Fourth Planet for GJ 876 in an Extrasolar Laplace Configuration

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Astrophysical Journal, in press arXive1006.4244

Continued radial velocity monitoring of the nearby M4V red dwarf star GJ 876 with Keck/HIRES has revealed the presence of a Uranus-mass fourth planetary companion in the system. The new planet has a mean period of $P_e = 126.6$ days (over the 12.6-year baseline of the radial velocity observations), and a minimum mass of $m_e \sin i_e = 12.9 \pm 1.7\, M_\oplus$. The detection of the new planet has been enabled by significant improvements to our radial velocity data set for GJ 876. The data have been augmented by 36 new high-precision measurements taken over the past five years. In addition, the precision of all of the Doppler measurements have been significantly improved by the incorporation of a high signal-to-noise template spectrum for GJ 876 into the analysis pipeline. Implementation of the new template spectrum improves the internal RMS errors for the velocity measurements taken during 1998-2005 from 4.1 $\mathrm{m\,s^{-1}}$ to 2.5 $\mathrm{m\,s^{-1}}$. Self-consistent, N-body fits to the radial velocity data set show that the four-planet system has an invariable plane with an inclination relative to the plane of the sky of $i = 59.5^\circ$. The fit is not significantly improved by the introduction of a mutual inclination between the planets "b" and "c," but the new data do confirm a non-zero eccentricity, $e_d = 0.207 \pm 0.055$ for the innermost planet, "d." In our best-fit coplanar model, the mass of the new component is $m_e = 14.6 \pm 1.7\, M_\oplus$. Our best-fitting model places the new planet in a 3-body resonance with the previously known giant planets (which have mean periods of $P_c = 30.4$ and $P_b = 61.1$ days). The critical argument, $\varphi_{\mathrm{Laplace}} = \lambda_c - 3\lambda_b + 2\lambda_e$, for the Laplace resonance librates with an amplitude of $\Delta\varphi_{\mathrm{Laplace}} = 40 \pm 13^\circ$ about $\varphi_{\mathrm{Laplace}} = 0^\circ$. Numerical integration indicates that the four-planet system is stable for at least a billion years (at least for the coplanar cases). This resonant configuration of three giant planets orbiting an

M-dwarf primary differs from the well-known Laplace configuration of the three inner Galilean satellites of Jupiter, which are executing very small librations about $\varphi_{\rm Laplace} = 180°$, and which never experience triple conjunctions. The GJ 876 system, by contrast, comes close to a triple conjunction between the outer three planets once per every orbit of the outer planet, "e."

Download/Website: `http://arxiv.org/abs/1006.4244`

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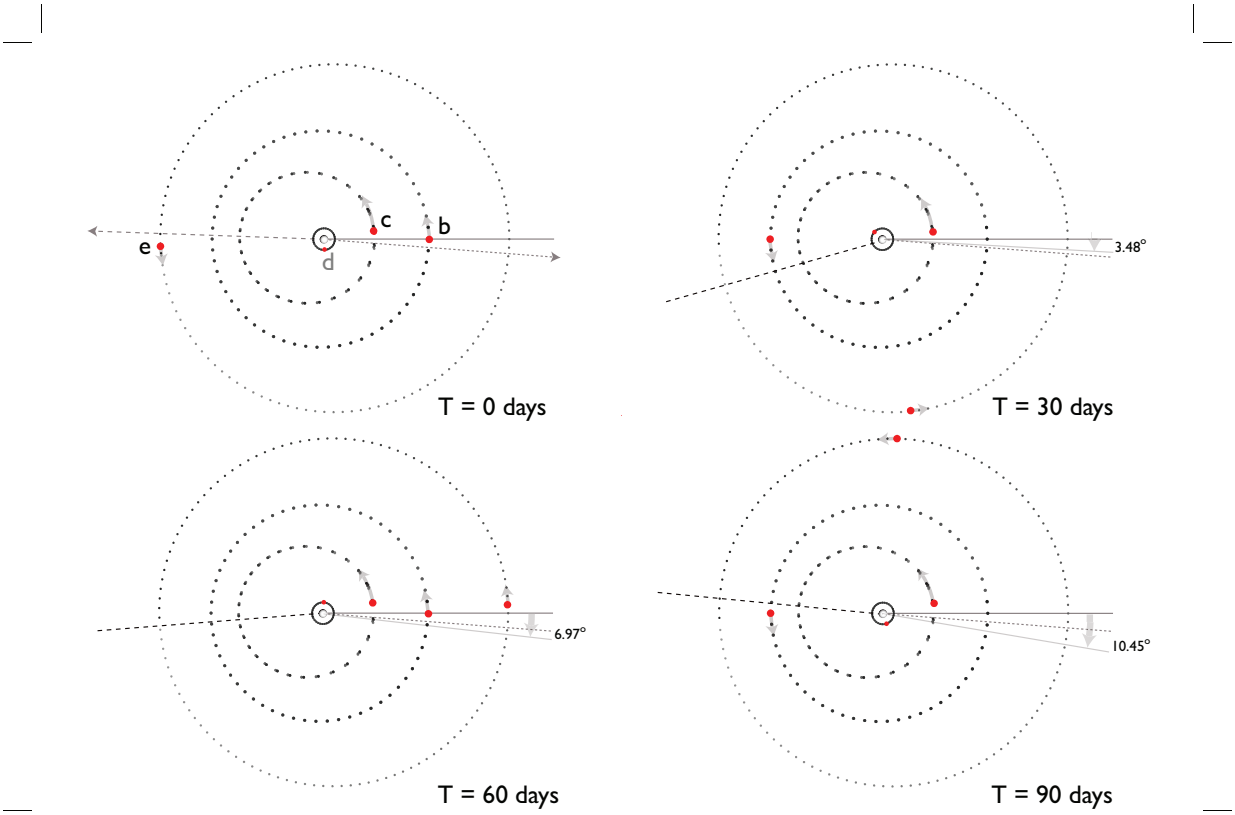

Figure 5: (Rivera et al.) Four configuration snapshots of the GJ 876 planetary system. Each panel shows the positions of the four planets at 120 successive one-day intervals starting from JD=2450608.093 (T=0 days), with the orbital positions at the listed times given by red dots. The diagrams are drawn in a frame that rotates to match the mean orbital precession of planet "b," which amounts to $-10.45°$ over the 90 days shown. Planet "b"'s apsidal line coincides with the x-axis. The apses for planets "c" and "e" are drawn with smaller-dashed and larger-dashed lines, respectively.

High-resolution infrared spectroscopy as a tool to detect false positives of transit search programs

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Astronomy & Astrophysics, in press (arXiv:1006.5030)

Transit search programs such as CoRoT and Kepler now have the capability of detecting planets as small as the Earth. The detection of these planets however requires the removal of all false positives. Although many false positives can be identified by a detailed analysis of the light-curves (LCs), the detections of others require additional observations. An important source of false positives are faint eclipsing binaries within the point spread function (PSF) of the target star. For example, triple stars are an important source of false positives. Unfortunately, most of the methods previously applied have difficulties in detecting these objects. We develop a new method that allows us to detect faint eclipsing binaries with a separation smaller than one arcsec from target stars. We thereby focus on binaries that mimic the transits of terrestrial planets. These binaries can be either at the same distance as the target star (triple stars), or at either larger, or smaller distances. A close inspection of the problem indicates that these systems contain either late-type stars, or stars of high extinction. Thus, in both cases the binaries are brighter in the infrared than in the optical regime. We show how high resolution IR spectroscopy can be used to remove these false positives. For the triple star case, we find that the brightness difference between a primary and an eclipsing secondary is about 9-10 mag in the visual but only about 4.5-5.9 magnitudes in the K-band. In the next step, we demonstrate how the triple star hypothesis can be excluded by taking a high-resolution IR spectrum. Simulations of these systems show that the companions can be detected with a false-alarm probability of $\sim 2\%$, if the spectrum has a signal-to-noise ratio (S/N) ≥ 100. We subsequently show that high-resolution IR spectra also allows to detect most of the false positives caused by foreground or background binaries. If high resolution IR spectroscopy is combined with photometric methods, virtually all false positives can be detected without RV measurements. It is thus possible to confirm transiting terrestrial planets with a modest investment of observing time.

Download/Website: `http://lanl.arxiv.org/abs/1006.5030`

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A Physically-Motivated Photometric Calibration of M Dwarf Metallicity

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Astronomy & Astrophysics, in press(astro-ph/1006.2850)

The location of M dwarfs in the $V - K_s$-M_{Ks} color-magnitude diagram (CMD) has been shown to correlate with metallicity. We demonstrate that previous empirical photometric calibrations of M dwarf metallicity exploiting this correlation systematically underestimate or overestimate metallicity at the extremes of their range. We improve upon previous calibrations in three ways. First, we use both a volume-limited and kinematically-matched sample of F and G dwarfs from the Geneva-Copehnagen Survey (GCS) to infer the mean metallicity of M dwarfs in the Solar Neighborhood. Second, we use theoretical models of M dwarf interiors and atmospheres to determine the effect of metallicity on M dwarfs in the $V - K_s$-M_{Ks} CMD. Third, though we use the GCS to infer the mean metallicity of M dwarfs in the Solar Neighborhood, our final calibration is based purely on high-resolution spectroscopy of FGK primaries with M dwarf companions as well as the trigonometric parallaxes and apparent V- and K_s-band magnitudes of those M dwarf companions. As a result, our photometric calibration explains an order of magnitude more of the variance in the calibration sample than previous photometric calibrations. We use our calibration to non-parametrically quantify the significance of the observation that M dwarfs that host exoplanets are preferentially in a

region of the $V-K_s$-M_{Ks} plane populated by metal-rich M dwarfs. We find that the probability p that planet-hosting M dwarfs are distributed across the $V-K_s$-M_{Ks} CMD in the same way as field M dwarfs is $p = 0.06 \pm 0.008$. Interestingly, the subsample of M dwarfs that host Neptune and sub-Neptune mass planets may also be preferentially located in the region of the $V-K_s$-M_{Ks} plane populated by high-metallicity M dwarfs. The probability of this occurrence by chance is $p = 0.40 \pm 0.02$, and this observation hints that low-mass planets may be more likely to be found around metal-rich M dwarfs. The confirmation of this hint would be in contrast to the result obtained for FGK stars, where it appears that metal-rich and metal-poor stars hosts Neptune-mass planets with approximately equal probability. An increased rate of low-mass planet occurrence around metal-rich M dwarfs would be a natural consequence of the core-accretion model of planet formation.

Download/Website: `http://arxiv.org/abs/1006.2850`

Contact: `kcs@ucolick.org`

Evidence of Possible Spin-Orbit Misalignment Along the Line of Sight in Transiting Exoplanet Systems

K.C. Schlaufman

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Astrophysical Journal, in press (astro-ph/1006.2851)

Of the 26 transiting exoplanet systems with measurements of the Rossiter-McLaughlin (RM) effect, eight have now been found to be significantly spin-orbit misaligned in the plane of the sky (i.e. RM misalignment angle $|\lambda| > 30^\circ$ and inconsistent with $\lambda = 0^\circ$). Unfortunately, the RM effect does not constrained the complement misalignment angle between the orbit of the planet and the spin of its host star along the line of sight. I use a simple model of stellar rotation benchmarked with observational data to statistically identify ten exoplanet systems from a sample of 75 for which there is likely a significant degree of spin-orbit misalignment along the line of sight: HAT-P-7, HAT-P-14, HAT-P-16, HD 17156, Kepler-5, Kepler-7, TrES-4, WASP-1, WASP-12, and WASP-14. All ten systems have host stellar masses M_* in the range $1.2\ M_\odot < M_* < 1.5\ M_\odot$, and the probability of this occurrence by chance is less than one in ten thousand. In addition, the planets in the candidate misaligned systems are preferentially massive and eccentric. The coupled distribution of misalignment from the RM effect and from this analysis suggests that transiting exoplanets are more likely to be spin-orbit aligned than expected given predictions for a transiting planet population produced entirely by planet-planet scattering or Kozai cycles and tidal friction. For that reason, there are likely two populations of close-in exoplanet systems: a population of aligned systems and a population of apparently misaligned systems in which the processes that lead to misalignment or to the survival of misaligned systems operate more efficiently in systems with massive stars and planets.

Download/Website: `http://arxiv.org/abs/1006.2851`

Contact: `kcs@ucolick.org`

The orbital motion, absolute mass, and high-altitude winds of exoplanet HD209458b

Ignas A.G. Snellen[1], *Remco J. de Kok*[2], *Ernst J.W. de Mooij*[1] *& Simon Albrecht*[3,1]

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[2] SRON, Sorbonnelaan 2, 3584 CA Utrecht, The Netherlands
[3] Department of Physics, and Kavli Institute for Astrophysics and Space Research, Massachusetts Institute of Technology, Cambridge USA

Nature, 465, 1049 (Arxiv:1006.4364)

For extrasolar planets discovered using the radial velocity method, the spectral characterization of the host star leads to a mass-estimate of the star and subsequently of the orbiting planet. In contrast, if also the orbital velocity of the planet would be known, the masses of both star and planet could be determined directly using Newton's law of gravity, just as in the case of stellar double-line eclipsing binaries. Here we report on the detection of the orbital velocity of extrasolar planet HD209458b. High dispersion ground-based spectroscopy during a transit of this planet reveals absorption lines from carbon monoxide produced in the planet atmosphere, which shift significantly in wavelength due to the change in the radial component of the planet orbital velocity. These observations result in a mass determination of the star and planet of 1.00 ± 0.22 Msun and 0.64 ± 0.09 Mjup respectively. A 2 km/sec blueshift of the carbon monoxide signal with respect to the systemic velocity of the host star suggests the presence of a strong wind flowing from the irradiated dayside to the non-irradiated nightside of the planet within the $0.01-0.1$ mbar atmospheric pressure range probed by these observations. The strength of the carbon monoxide signal suggests a CO mixing ratio of $1-3\text{x}10^{-3}$ in this planet's upper atmosphere.

Download/Website: `http://www.nature.com/nature/journal/v465/n7301/full/nature09111.html`

Contact: `snellen@strw.leidenuniv.nl`

The Earth as an extrasolar transiting planet: Earth's atmospheric composition and thickness revealed by Lunar eclipse observations

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Astronomy & Astrophysics, accepted (arXiv:1007.0008)

An important goal within the quest for detecting an Earth-like extrasolar planet, will be to identify atmospheric gaseous bio-signatures. Observations of the light transmitted through the Earth's atmosphere, as for an extrasolar planet, will be the first important step for future comparisons. We have completed observations of the Earth during a lunar eclipse, a unique situation similar to that of a transiting planet. We aim at showing what species could be detected in its atmosphere at optical wavelengths, where a lot of photons are available in the masked stellar light. We present observations of the 2008 August 16 Moon eclipse performed with the SOPHIE spectrograph at the Observatoire de Haute-Provence (France). Locating the spectrograph's fibers in the penumbra of the eclipse, the

Moon irradiance is then a mix of direct, unabsorbed Sun light and solar light that has passed through the Earth's atmosphere. This mixture essentially reproduces what is recorded during the transit of an extrasolar planet. We report here the clear detection of several Earth atmospheric compounds in the transmission spectra, such as ozone, molecular oxygen, and neutral sodium as well as molecular nitrogen and oxygen through the Rayleigh signature. Moreover, we present a method that allows us to derive the thickness of the atmosphere versus the wavelength for penumbra eclipse observations. We quantitatively evaluate the altitude at which the atmosphere becomes transparent for important species like molecular oxygen and ozone, two species thought to be tightly linked to the presence of life. The molecular detections presented here are an encouraging first attempt, necessary to better prepare for the future of extremely-large telescopes and transiting Earth-like planets. Instruments like SOPHIE will be mandatory when characterizing the atmospheres of transiting Earth-like planets from the ground and searching for bio-marker signatures.

Contact: alfred@iap.fr

The Edgeworth-Kuiper debris disk

Ch. Vitense, Alexander V. Krivov, T. Löhne

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Astronomy & Astrophysic, submitted and accepted

The Edgeworth-Kuiper belt (EKB) and its presumed dusty debris is a natural reference for extrsolar debris disks. We re-analyze the current database of known transneptunian objects (TNOs) and employ a new algorithm to eliminate the inclination and the distance selection effects in the known TNO populations to derive expected parameters of the "true" EKB. Its estimated mass is $M_{EKB} = 0.12 M_{\oplus}$, which is by a factor of ~ 15 larger than the mass of the EKB objects detected so far. About a half of the total EKB mass is in classical and resonant objects and another half is in scattered ones. Treating the debiased populations of EKB objects as dust parent bodies, we then "generate" their dust disk with our collisional code. Apart from accurate handling of destructive and cratering collisions and direct radiation pressure, we include the Poynting-Robertson (P-R) drag. The latter is known to be unimportant for debris disks around other stars detected so far, but cannot be ignored for the EKB dust disk because of its much lower optical depth. We find the radial profile of the normal optical depth to peak at the inner edge of the classical belt, $\approx 40\ AU$. Outside the classical EKB, it approximately follows $\tau \propto r^{-2}$ which is roughly intermediate between the slope predicted analytically for collision-dominated ($r^{-1.5}$) and transport-dominated ($r^{-2.5}$) disks. The size distribution of dust is less affected by the P-R effect. The cross section-dominating grain size still lies just above the blowout size ($\sim 1...2\ \mu m$), as it would if the P-R effect was ignored. However, if the EKB were by one order of magnitude less massive, its dust disk would have distinctly different properties. The optical depth profile would fall off as $\tau \propto r^{-3}$, and the cross section-dominating grain size would shift from $\sim 1...2\ \mu m$ to $\sim 100\ \mu m$. These properties are seen if dust is assumed to be generated only by known TNOs without applying the debiasing algorithm. An upper limit of the in-plane optical depth of the EKB dust set by our model is $\tau = 2 \times 10^{-5}$ outside $30\ AU$. If the solar system were observed from outside, the thermal emission flux from the EKB dust would be about two orders of magnitude lower than for solar-type stars with the brightest known infrared excesses observed from the same distance. Herschel and other new-generation facilities should reveal extrasolar debris disks nearly as tenuous as the EKB disk. We estimate that the Herschel/PACS instrument should be able to detect disks at a $\sim 1...2 M_{EKB}$ level.

Download/Website: http://arxiv.org/abs/1006.2220

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3 Abstracts of theses

Theoretical studies on brown dwarfs and extrasolar planets

R. Heller[1,2]

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[2] Graduiertenkolleg 1351 'Extrasolar planets and their host stars', funded by the Deutsche Forschungsgesellschaft

Library of the Hamburger Sternwarte (University of Hamburg), handed in on July 9, 2010

With our human self-reflection we embody the fact that the Universe thinks about itself. About 13.75 billion years after a Big Bang, dead matter became something that is able to say "Je pense, donc je suis.", or "I think, therefore I am". For several thousands of years, we are wondering what it means 'to be', what that is which has being, where did it all come from and – why. In quest of answers to these questions, some dig into the shortest scales of matter, so they may penetrate the power that holds the Universe together. Others study the forms of life or explore the human brain, some believe in an omnipotence and some, finally, use devices to look deep into the sky. About 20 years ago, these stargazers – astronomers, who used to name celestial objects in former times, and astrophysicists, who study their physical qualities – discovered the first planet that orbits a distant star. Over the intervening years, the number of such confirmations has increase to several hundreds. Moreover, scientists discovered objects, which are neither stars nor planets, but have intermediate masses. These 'brown dwarfs' constitute the connecting link between the two regimes. And both, stars as well as planets, can only be understood comprehensively in their context with brown dwarfs.

The mere number of these so-called extrasolar planets, or exoplanets, does not tell us too much about our cosmological context. We want to study them. This thesis aims at the gravitational interaction of stellar and substellar objects and at the possibilities for their exploration. The picture of an isolated planet that orbits its host star undeviatingly and forever is obsolete. Recent discoveries have shown that the fate of planets in close orbits is determined by star-planet interaction. And tidal effects turned out to play a key role. Even more, the structure of young brown dwarfs essentially depends on the tidal processes driven by close companions.

Part I of this book, with its Chaps. 2 to 4, gives an introduction to the basic physics and to the objects we will deal with. In Part II, which makes up the cumulative contingent of my publications, Chap. 5 is dedicated to the tidal effects on brown dwarfs. This issue had not been considered before. Here, we point out how tidal processes affect the energy budget of these substellar objects and how they cause deviations from the standard evolution tracks of isolated brown dwarfs. We apply different established tidal models to the case of the currently only known eclipsing brown dwarf binary, and we identify their differences as well as possibilities for their validation or falsification. In the following, I address the impact of tidal effects on the habitability of exoplanets. As we find, the concept of the so-called (circumstellar) 'habitable zone' requires a revision in due consideration of tidal processes. Chapter 6 is devoted to the prediction of extrasolar planet transits and data analysis. We present sky maps of the expectation values of transits as a projection on the celestial plane. We also introduce a mathematical model, which allows for the deduction of the planet's orbital eccentricity, orientation of periastron, geometric albedo, its radius as a fraction of the stellar radius, its orbital period, and the inclination of the orbital plane with respect to the observer's line of sight. In Part III, I take the liberty to conclude, and in the appendix, finally, I present a German popular science publication of my studies on extrasolar transiting planets.

Download/Website: `http://www.hs.uni-hamburg.de/EN/Ins/Per/Heller`

Contact: `rheller@hs.uni-hamburg.de`

4 Conference announcements

First Kepler Science Conference

Alan Boss
Department of Terrestrial Magnetism Carnegie Institution of Washington 5241 Broad Branch Road, N.W. Washington, D.C. 20015-1305 U.S.A.

NASA Ames Research Center, Moffett Field, California in the Building 3 Conference Center, December 5-6-7, 2011

All Kepler Mission science results, from exoplanet transits and the frequency of Earth-like worlds to asteroseismology. All interested scientists and journalists are welcome.

Download/Website: `http://kepler.nasa.gov/Science/keplerconference/`

International Workshop on Extrasolar Planets

Nader Haghighipour
University of Hawaii Institute for Astronomy 2680 Woodlawn Drive Honolulu, HI 96822-1897

IPM School of Astronomy & Sharif Univ. of Technology, Kish Island, Persian Gulf, Iran, Jan. 29 Feb. 11 , 2011

The Astronomy school of the Institute for Research in Fundamental Science (IPM) and The Sharif University of Technology announce an international workshop on formation, detection, dynamical evolution and habitability of extrasolar planets in Kish Island of Iran. Featuring an extensive program including lectures, and invited and contributed talks, this workshop aims at familiarizing the participants with different aspects of research in extrasolar planetary science. Participation is open to all. Advance graduate students and recent postdocs are strongly encouraged to apply.
Organizing Committee: Sohrab Rahvar, IPM & SUT, Iran; Martin Dominik, Univ. of St. Andrews, UK; Nader Haghighipour, Univ. of Hawaii, USA; Habib Khosroshahi, IPM, Iran; Reza Mansouri, IPM & SUT, Iran
Lecturers: Phil Armitage, Univ. of Colorado, USA; Martin Dominik, Univ. of St. Andrews, UK; Nader Haghighipour, Univ. of Hawaii, USA; Paul Kalas, Univ. of California, Berkeley, USA; Lisa Kaltenegger (TBC), Harvard Univ., USA; Willy Kley, Univ. of Tuebingen, Germany; Rosemary Mardling, Monash Univ., Australia; Don Pollacco, Queen's Univ. Belfast, UK; Stephane Udry, Geneva University, Switzerland.

Download/Website: `http://www.astro.ipm.ir/ESPW/index.htm`

Contact: `astro@ipm.ir`

5 Jobs and Positions

The Michael West Research Fellowship in Astrophysics

Prof. Alan Fitzsimmons
School of Mathematics and Physics, Queen's University Belfast

Belfast, Closing Date 30th July 2010

Applications are invited for the 3-year Michael West Research Fellowship, located within the Astrophysics Research Centre (ARC) of the School of Mathematics and Physics. This fully-funded fellowship will allow the successful applicant to pursue their own astronomical research programme, which should be complementary to those already being undertaken within ARC. A novel aspect of this fellowship is that the fellow will make a significant contribution to the astronomy outreach programme in the School. An appropriate research support package will be provided.

Further information on ARC activities may be found on the ARC website (see below).

Informal enquiries may be directed to Prof. Alan Fitzsimmons (telephone: +44 2890 973124, email:a.fitzsimmons@qub.ac.uk).

Applicants must have the following:

- A PhD in a relevant subject either awarded or at least submitted at the time of taking up the post.
- Experience of relevant research in astrophysics in an area that will complement and enhance the key research areas within ARC.
- High quality refereed publications commensurate with applicant's career stage.
- Experience in Public Understanding of Science activities, for example through lectures, written articles, hands-on projects or other forms of engagement.

An application pack for the post, containing further details of the essential and desirable criteria, with post reference 10/101363, is available from our website: http://www.qub.ac.uk/jobs

Additional information: ARC is a highly successful group, with 10 staff members, 17 postdocs and research fellows, and a large number of research students. ARC personnel are leading members of the WASP consortium and the Pan-STARRS1 science consortia. Recent developments include the construction of the ROSA high-speed solar imager.

Salary: GBP 29,853 - GBP 34,607 per annum (including contribution points).
Closing date: 4.00 pm, Friday 30 July 2010.

Download/Website: `http://star.pst.qub.ac.uk/`

Contact: `a.fitzsimmons@qub.ac.uk`

Postdoctoral Fellow(s) – Exo-Planets, Brown Dwarfs and Young Stars

Prof. Ray Jayawardhana

Toronto, Canada, Fall 2010 (flexible)

Applications are invited for one or more postdoctoral research position(s) at the University of Toronto to start in Fall 2010 or later. The successful candidate(s) will work with Prof. Ray Jayawardhana and his collaborators on observational and analytical studies of extra-solar planets, brown dwarfs and young stars, and will be encouraged to pursue independent research on related topics. On-going projects include photometric and spectroscopic studies of exo-planets (e.g., approved CFHT Large Program for ground-based secondary eclipse detection), high-contrast imaging searches for companions around young stars, the SONYC (Substellar Objects in Nearby Young Clusters) ultra-deep survey, and investigations of brown dwarf variability, using data from VLT, Subaru, Gemini, Keck, CFHT and other major observatories. The position is for two years, with extension to a third year possible, and comes with a competitive salary and funds for research expenses. Applicants should send a curriculum vitae, a description of research interests and plans and a list of publications, and should arrange for three letters of recommendation to be sent directly to rayjay@astro.utoronto.ca Applications received before 2010 August 15 will receive full consideration. Early expressions of interest and inquiries are welcome.

Contact: `rayjay@astro.utoronto.ca`

6 Announcements

NStED Access to Periodogram Service, Public Kepler Data and HATNet Survey Data

David R. Ciardi on behalf of the NStED team
NASA Exoplanet Science Institute/Caltech

Announcement of access,

The NASA Exoplanet Science Institute (NExScI) is pleased to announce a significant update to the NASA Star and Exoplanet Database (NStED). Each of the 210,000+ public Kepler light curves are integrated with the newly-released NStED periodogram service. The periodogram service employs three different algorithms including Lomb-Scargle and Box Least-Squares and generates a periodicity rank for each tested frequency and a phased light curve for each peak in the periodogram. The periodogram parameters are adjustable through a web-based interface allowing users to refine the periodicity search. The Kepler data are searchable at NStED from
http://nsted.ipac.caltech.edu/applications/ETSS/Kepler_index.html
NStED also now provides a portal to data from the Hungarian-made Automated Telescope Network (HATNet) project. The initial release includes more than 5000 lightcurves of variable stars detected by the HATNet project from 72 HATNet fields with declinations between +15 degrees and +52 degrees. The survey covers approximately 4000 square degrees, or roughly 10% of the sky. The HATNet data are available at
http://nsted.ipac.caltech.edu/applications/ETSS/HATNet_index.html
The general portal to the NStED exoplanet and stellar data is at
http://nsted.ipac.caltech.edu

Download/Website: `http://nsted.ipac.caltech.edu/`

Contact: `http://nsted.ipac.caltech.edu/applications/Helpdesk`

7 As seen on astro-ph

The following list contains all the entries relating to exoplanets that we spotted on astro-ph during June 2010. If you spot any that we missed, please let us know and we'll include them in the next issue. And of course, the best way to ensure we include your paper is to send us the abstract.

Exoplanets

astro-ph/1006.0737: **Near-Infrared Thermal Emission from TrES-3b: A Ks-band detection and an H-band upper limit on the depth of the secondary eclipse** by *Bryce Croll, Ray Jayawardhana, Jonathan J. Fortney*

astro-ph/1006.0657: **Habitability of exoplanetary systems with planets observed in transit** by *Barrie W Jones, P Nick Sleep*

astro-ph/1006.1348: **Transit timing variation in exoplanet WASP-3b** by *G.Maciejewski, D.Dimitrov, R.Neuhaeuser et al.*

astro-ph/1006.1660: **Atmosphere and Spectral Models of the Kepler-Field Planets HAT-P-7b and TrES-2** by *David S. Spiegel, Adam Burrows*

astro-ph/1006.1953: **NICMOS Observations of the Transiting Hot Jupiter XO-1b** by *Christopher J. Burke, P. R. McCullough, E. Bergeron*

astro-ph/1006.2069: **Estimating the masses of extra-solar planets** by *C. A. Watson, S.P. Littlefair, A. Collier Cameron*

astro-ph/1006.2135: **Planet migration: self-gravitating radiation hydrodynamical models of protoplanets with surfaces** by *Ben A. Ayliffe, Matthew R. Bate*

astro-ph/1006.2503: **Tidal Effects on the Habitability of Exoplanets: The Case of GJ 581 d** by *Rory Barnes, Brian Jackson, Rene Heller*

astro-ph/1006.2584: **Toward a Deterministic Model of Planetary Formation VI: Dynamical Interaction and Coagulation of Multiple Rocky Embryos and Super-Earth Systems around Solar Type Stars** by *S. Ida, D. N. C. Lin*

astro-ph/1006.2605: **WASP-21b: a hot-Saturn exoplanet transiting a thick disc star** by *F. Bouchy, L. Hebb, I. Skillen et al.*

astro-ph/1006.2707: **Classical and relativistic node precessional effects in WASP-33b and perspectives for detecting them** by *Lorenzo Iorio*

astro-ph/1006.2763: **Five Kepler target stars that show multiple transiting exoplanet candidates** by *Jason H. Steffen, Natalie M. Batalha, William J. Borucki et al.*

astro-ph/1006.2799: **Characteristics of Kepler Planetary Candidates Based on the First Data Set: The Majority are Found to be Neptune-Size and Smaller** by *William J. Borucki, for the Kepler Team*

astro-ph/1006.2949: **CoRoT-10b: a giant planet in a 13.24 day eccentric orbit** by *A. S. Bonomo, A. Santerne, R. Alonso et al.*

astro-ph/1006.3070: **The Directly Imaged Planet around the Young Solar Analog 1RXS J160929.1-210524: Confirmation of Common Proper Motion, Temperature and Mass** by *David Lafreniere, Ray Jayawardhana, Marten H. van Kerkwijk*

astro-ph/1006.3314: **A giant planet imaged in the disk of the young star Beta Pictoris** by *A.-M. Lagrange, M. Bonnefoy, G. Chauvin et al.*

astro-ph/1006.3525: **Light scattering from exoplanet oceans and atmospheres** by *Michael E. Zugger, James F. Kasting, Darren M. Williams et al.*

astro-ph/1006.3580: **A Revised Orbital Ephemeris for HAT-P-9b** by *Jason A. Dittmann, Laird M. Close, Louis J. Scuderi et al.*

astro-ph/1006.3727: **The Value of Systems with Multiple Transiting Planets** by *Darin Ragozzine, Matthew J. Holman*

astro-ph/1006.3834: **Non-Keplerian Dynamics** by *Daniel C. Fabrycky*

astro-ph/1006.4121: **Rotation periods of exoplanet host stars** by *Elaine Simpson, Sallie Baliunas, Greg Henry et al.*

astro-ph/1006.4161: **Hot Stars with Hot Jupiters Have High Obliquities** by *Joshua N. Winn, Daniel Fabrycky, Simon Albrecht et al.*

astro-ph/1006.4224: **The Lick-Carnegie Exoplanet Survey: A Uranus-mass Fourth Planet for GJ 876 in an Extrasolar Laplace Configuration** by *Eugenio J. Rivera, Gregory Laughlin, R. Paul Butler et al.*

astro-ph/1006.4336: **Archean Paleo-climate: The first snowball?** by *Hector Javier Durand-Manterola*

astro-ph/1006.4364: **The orbital motion, absolute mass, and high-altitude winds of exoplanet HD209458b** by *Ignas A.G. Snellen, Remco J. de Kok, Ernst J.W. de Mooij et al.*

astro-ph/1006.4443: **Homogeneous studies of transiting extrasolar planets. III. Additional planets and stellar models** by *John Southworth*

astro-ph/1006.4464: **High-precision photometry by telescope defocussing. III. The transiting planetary system WASP-2** by *John Southworth, L. Mancini, S. Calchi Novati et al.*

astro-ph/1006.4599: **Characterizing Transiting Extrasolar Planets with Narrow-Band Photometry and GTC/OSIRIS** by *Knicole D. Colon, Eric B. Ford, Brian Lee*

astro-ph/1006.4702: **On the radiative equilibrium of irradiated planetary atmospheres** by *Tristan Guillot*

astro-ph/1006.4814: **On the rotational behavior of parent stars of extrasolar planets** by *Sanzia Alves, Jose Dias do Nascimento Jr, Jose Renan de Medeiros*

astro-ph/1006.4884: **The SOPHIE search for northern extrasolar planets III. A Jupiter-mass companion**

around HD 109246 by *I. Boisse, A. Eggenberger, N.C. Santos et al.*

astro-ph/1006.4984: **The SOPHIE search for northern extrasolar planets III. A Jupiter-mass companion around HD 109246** by *I. Boisse, A. Eggenberger, N.C. Santos et al.*

astro-ph/1006.5089: **WASP-8b: a retrograde transiting planet in a multiple system** by *Didier Queloz, David Anderson, Andrew Collier Cameron et al.*

astro-ph/1006.5680: **Analysis of Kepler's short-cadence photometry for TrES-2b** by *David M. Kipping, Gaspar A. Bakos*

astro-ph/1006.5846: **Giant Planet Formation** by *Gennaro D'Angelo, Richard H. Durisen, Jack J. Lissauer*

astro-ph/1006.5961: **The non-resonant, relativistic dynamics of circumbinary planets** by *Cezary Migaszewski, Krzysztof Gozdziewski*

Disks

astro-ph/1006.1220: **Have proto-planetary discs formed planets?** by *J.S. Greaves, W.K.M. Rice*

astro-ph/1006.2220: **The Edgeworth-Kuiper debris disk** by *Christian Vitense, Alexander V. Krivov, Torsten Lohne*

astro-ph/1006.2581: **N-Body Simulation of Planetesimal Formation through Gravitational Instability of a Dust Layer in Laminar Gas Disk** by *Shugo Michikoshi, Eiichiro Kokubo, Shu-ichiro Inutsuka*

astro-ph/1006.3845: **The inner regions of protoplanetary disks** by *C. P. Dullemond, J. D. Monnier*

astro-ph/1006.5244: **CI observations in the CQ Tau proto-planetary disk: evidence for a very low gas-to-dust ratio ?** by *E. Chapillon, B. Parise, S. Guilloteau et al.*

Instrumentation and Techniques

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